



Emerging researcher article

The design and implementation of a proficiency test for assessors of fingerprint quality, to facilitate collaborative practise in fingerprint research



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ABSTRACT

Significant numbers of institutions are carrying out fingerprint based research, yet there appears to be little inter-institution consistency in the approaches used to assess the quality of the samples produced. Inter-institution consistency in quality assessment would lead to inevitable benefits in collaborating research projects, given that data from multiple projects may be combined, or compared. In order for such quality assessment schemes to be effectively used across multiple institutions, proficiency in using such approaches should be identified to ensure parity. Intra-institution controls on fingerprint quality assessment are likely to help manage variations between researchers from the same institution and/or project(s). Proficiency testing (PT) is a popular means of comparing and monitoring the competency of individuals, whilst also assessing the validity of data and conclusions. This project aimed to develop a proficiency testing scheme for the assessment of fingerprint quality for researchers. A grading system was developed to assess the quality of fingerprints generated within research projects. A large collection of test fingerprint samples was created controlling variables such as force, fingerprint composition and surface type. An 'inter-laboratory testing scheme' design was used for the proficiency test and established fingerprint researchers participated in the project to produce known values for 6 chosen test samples for round one of the testing scheme, described in this paper. Second year BSc (Hons) Forensic Science and Forensic Investigation student participants from the host institution completed the proficiency test as part of a fingerprint practical. Results indicated that student participants involved in this project were not able to demonstrate a satisfactory level of proficiency of fingerprint quality assessment using this grading system, which was attributed to their relative experience in assessing the quality of fingerprints compared to 'experts' in fingerprint analysis. Results have highlighted considerations for future grading systems, and additional training requirements of users.

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1. Introduction

At present there are several approaches that are capable of facilitating the assessment of fingerprint quality, which are selected according to the requirements of the research project. Quantitative approaches may involve subjective estimates of mark quality, which commonly assign grades to the mark based on certain criteria [1–5]. Other quantitative approaches quantify the amount of ridge detail, for example, by counting the number of ridge characteristics [6–8]. Alternative quantitative methods of quality assessment may adopt a more objective approach; such as the calculation of a contrast index [9], or utilising computer software to generate quantitative data, which is then used as the quality indicator [10]. In some published studies the quality measurement has been tailored to the specific outcomes of the variable

under study, for example, the measurement of luminescence of DFO developed fingerprints [11], or split marks may be used to establish differences in the quality of two marks that have been subjected to different treatments [12]. Qualitative approaches to fingerprint quality assessment may describe trends or features present within groups of fingerprints, rather than breaking down the analysis to individual fingerprints. Qualitative approaches will not be discussed any further here, as the nature of this research has a quantitative focus.

There has been no single project to critically compare all existing methods of assessing fingerprint quality. Approaches that favour subjective estimates of quality can provide criteria that are tailored to the specific needs of the project under investigation; yet often attract criticism regarding their reliability with respect to their levels of discrimination, repeatability, and accuracy. Some may argue that these issues are alleviated with objective methodologies. On the contrary, objective methods can be time consuming, and reliant on existing hardware and software. An effective method of fingerprint quality assessment must have the ability to accurately discriminate between fingerprints

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of different qualities. Their use as part of a scientific investigation also requires such methods to be robust in terms of their ability to be repeated by the same user, or between users.

Significant numbers of institutions are carrying out fingerprint based research, yet there appears to be little inter-institution consistency in the approaches used to assess the quality of the samples produced. There would be inevitable benefits from the utilisation of a generic approach to assessing fingerprint quality, given that data from multiple projects may be combined, or compared. It would enable more effective collaboration between research institutions.

As described in this literature review, grading systems are a very popular means of assessing fingerprint quality, and there is evidence to support their use as a reliable and consistent means of assessing fingerprint quality [13]. The use of a grading scheme for fingerprint quality assessment ideally should involve a quality assurance system to ensure appropriate and consistent use. It is also important that grading schemes contain adequate and robust guidance to users, to provide transparency in the approach, and to encourage others to align to it. If quality assurance is not considered then an inappropriate interpretation of fingerprint quality may occur, affecting the accuracy and value of subsequent conclusions. One such method that could be used to check for competency in using a grading scheme and the subsequent quality assessment of a fingerprint is proficiency testing. Proficiency testing (PT) is a popular means of comparing and monitoring the capability of individuals, whilst also assessing the validity of data and conclusions [14]. Proficiency testing can be utilised for a variety of applications including; assessing the performance of individual laboratories and personnel in specific measurements or observations, identifying any problems relating to a laboratory or member of staff, establishing the effectiveness of new and extant measurement, and interpretation methods and to initiate corrective procedures for laboratories if required [15]. In the context of this study, proficiency testing is taken as assessing the competency of individuals rather than whole laboratories, although the proficiency test has been designed so as to be able to test multiple institutions in the future. Proficiency test design can be varied depending on the number and nature of the samples being analysed and the specific analytical question(s) being posed by the test. Tests may focus upon qualitative or quantitative analyses; interpretation based observations; or data transformation [16]. Regardless of test type, the main considerations, as stated by The International Laboratory Accreditation Cooperation (ILAC) in proficiency test design include; nomination of the most useful analyses to be undertaken (these should reflect forensic casework as closely as possible); the number and type of test sample; instructions for participants; the statistical approaches to be used to assign known values to test samples and assess data and the reporting format for results [17]. These design options are comprehensively described for proficiency test providers in the ISO/IEC Guide 43–1:1997 [18], and the more recent ISO/IEC 17043:2010 Conformity Assessment: General Requirements for Proficiency Testing [19], which is used in UKAS accreditation. These guides provide guidance on how test samples may be prepared, processed, checked, stored and transported. In addition to this, ISO 13528:2005 outlines different statistical methods for proficiency testing schemes [20]. The UK Forensic Regulator's Codes of Conduct for fingerprint identification states that forces must participate in inter-laboratory comparisons or proficiency testing in the area of fingerprint comparison [21].

In forensic science, proficiency testing is a well-known valuable form of quality control and is now an integral part of the UKAS accreditation process for forensic laboratories. As part of this process, certain standards must be adhered to, particularly ISO/IEC 17025:2005 [22]. Since the widespread introduction of PT schemes in forensic science, a large number of proficiency tests have now been developed in a broad range of evidence types, including fingerprint examination [23]. Currently there is no published scheme that can be used to investigate

the potential differences between individuals in the assessment of fingerprint quality for research purposes, as schemes traditionally focus upon the proficiency of individuals to carry out the ACE-V method and their interpretation of unknown fingerprint comparisons. The use of a proficiency test for fingerprint quality assessment would introduce quality assurance protocols to the methodological approach. Testing may commence at any point throughout the project to ensure inter- and intra-person competencies.

The aim of this project was to design and implement a proficiency test for fingerprint quality assessors. The authors are aware of alternative research examining the sufficiency of fingerprint ridge detail for identification which is relevant to staff working within fingerprint laboratories [24]. In this research project the assessment is not designed to influence the results of identification as it is aimed at research personnel. Assessments of fingerprint quality within a fingerprint bureau are more likely to focus upon on the quantity of ridge detail that is available within the mark, and are less inclined to assign a quality score, whereas fingerprint research projects frequently consider and score additional and alternative criteria. This approach could impact upon collaborative practise considerably given that the scale of some research projects may be insufficient to inform practise or for publication purposes. This is particularly pertinent in Higher Education institutions given the scale of research being carried out, and therefore there is the potential for university students and research institutions to collaborate. In any one year the host institution typically directs 8 full time Undergraduate BSc projects and 3 MSc projects specifically in a fingerprint area. Appropriate quality assurance measures are only likely to strengthen the methodological approach.

2. Materials and methods

The proficiency test for the assessment of quality of fingerprints was designed and based, where appropriate upon the guidelines and standards stated in the introduction [17–20]. The overall test design was broken down into the following areas;

- I. The parameters to be tested;
- II. Creation of proficiency test samples;
- III. Design of proficiency test including documentation and statistical approach;
- IV. Proficiency test implementation.

Each one of these areas will be addressed in turn.

2.1. Test parameters

An existing subjective grading system was used as the tool to assess fingerprint quality on the basis that despite the existence of several methodologies, the 'grading' approach was considered to be the most common. Justification for the design of the grading system can be found elsewhere [25]. It is not the focus of this paper given that the authors accept that different methods of quality assessment exist to meet the needs of the individual research project. In summary however, this particular grading system was developed via consultation with existing experienced fingerprint researchers from a variety of institutions. Its criteria were designed to reflect those frequently encountered in approaches to quality assessment, and/or those deemed important to denote fingerprint quality.

The grading system assessed the quality of the fingerprint according to the following four criteria:

1. The quantity of the fingerprint available for analysis;
2. The quantity of the fingerprint (from 1) that was occupied by usable ridge detail;
3. Friction ridge continuity within the mark;
4. The level of contrast between the ridges and the background.

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